Sudan University of Science and Technology

College of Graduate Studies

Measurement of Renal Pelvis Diameter with MDCT among Sudanese Population

قياس ابعاد حوض الكلية لدى السودانيين باستخدام الاشعة المقطعية متعددة الكواشف

A thesis submitted for partial fulfillment of the requirement of M.Sc. degree in Diagnostic Radiological Technology.

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الاية

قال تعالى:

"وَمَا تَكُونُ فِي شَأْنٍ وَمَا تَتْلُو مِنْهُ مِنْ قُرْآنٍ وَلَا تَعْمَلُونَ مِنْ عَمَلٍ إِلَّا كُنَّا عَلَيْكُمْ شُهُودًا إِذْ تُفِيضُونَ فِيهِ ۚ
وَمَا يَعْزُبُ عَنْ رَبِّكَ مِنْ مِثْقَالِ ذَرَّةٍ فِي الْأَرْضِ وَلَا فِي السَّمَاءِ وَلَا أَصْغَرَ مِنْ ذَٰلِكَ وَلَا أَكْبَرَ إِلَّا فِي كِتَابٍ مُبِينٍ" ﴿٦١﴾

سورة يونس﴿61﴾

Dedication

Every work needs self-effort as well as guidance and supporting of those who close to you

Our humble effort we dedicate to our family and friends

Along with all hard working and respected teachers.

Acknowledgements

First and foremost, we would like to thank God, for giving us courage and strength during this research.

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Abstract

This study was executed to demonstrate dimension of renal pelvic (length and width in three levels); the study was conducted at CT departments in Nilain private center and Alribat hospital from April 2018 to Oct. 2018.

Random samples of fifty patients whom referred to CT department with CTU request. 25 male and 25 females with different ages were collected; axial and sagittal cuts in addition to reconstructed coronal section were done to calculate the renal pelvic clearly.

From the study the RT. Renal pelvic was greater than the LT. Renal pelvic dimensions because the liver press the right kidney.

Determine the renal pelvic dimension help in accuracy of diagnoses because there was direct impact between width of renal pelvic and hydronephrosis.

Multidetector computed tomography is the modality of choice to determine dimension of renal pelvic and to visualize some pathological condition.

مستخلص الدراسة

اجريت هذة الدراسة لمعرفة الابعاد التشريحية لحوض الكلية (الطول والعرض في ثلاثية مستويات) وقد اجريت الدراسة في كل من مركز النيلين ومستشفى الرباط الجامعي في الفترة من ابريل 2018 – اكتوبر 2018م.

اخذت عينة عشوائية من خمسين مريض تم تحويلهم الى قسم الاشعة المقطعية بطلب فحص الاشعة المقطعية الملونة للجهاز البولى (25 من الرجال 25 من النساء) في مختلف الاعمار وقد خضع جميع المرضى لاجراء الوضعين (المحوري والسهمي) بالاضافة للوضع التاجي المركب وذلك لقياس حجم حوض الكلية بوضوح.

اوضحت الدراسة ان حوض الكلية اليمين اكبر من حوض الكلية اليسار وان تحديد ابعاد حوض الكلية يساعد في سهولة ودقة التشخيص لان لعرض الكلية علاقة بالتموه الكلوي.

اوضححت الدراسة ايضا ان الاشعة المقطعية متعددة الكواشف هي الخيار الامثل لتحديد ابعاد حوض الكلية وتحديد الامراض.

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List of Abbreviations

Abbreviation	Full Name
MDCT	Multidetector Computed Tomography
ADH	Antidiuretic Hormone
CT	Computed Tomography
CTU	Computed tomography urology
IVP	Intravenous Paleography
IVU	Intravenous Urography
MRI	Magnetic Resonance Imaging
PCS	Pelvicalyceal System
PTH	Prathyroid Hormone
RAS	Renin Angiotensin System
SST	Single Slice CT
VRT	Volum Rendring Technique

CHAPTER ONE

CHAPTER ONE

Introduction

In medical, "Imaging" is the general term for any technique used to provide pictures of bones and organs inside the body. Imaging techniques consist of X- rays, Ultrasound, Magnetic Resonance Imaging (MRI) , and Computerize Tomography (CT) scans. Evaluation of the kidneys and Pelvicalyceal System (PCS) can be achieved by several possible protocols. (Rodgers, 2006)

Ultrasonography is often the initial imaging technique because it can be done safely even when kidney function is impaired. It is noninvasive and painless and requires no radiopaque contrast agent. Ultrasonography provides some indirect information about kidney function, is an excellent way to estimate kidney size and position, readily detects obstruction, and helps diagnose structural abnormalities. But ultrasonography inferior to (CT) in the diagnosis of kidney tumors. (Rodgers, 2006)

Intravenous urography (IVU), also called intravenous pyelography or (IVP) uses a radiopaque contrast agent given through a vein to provide an x-ray image of the kidneys, ureters, and bladder. However, IVU can better detect small abnormalities of the ureters and some abnormalities of the kidneys. Intravenous Pylelography is often done for people with blood in the urine, even if the blood is not visible to the naked eye. It is

also often done for people whose doctors' suspect may have cancer involving the ureters or other urinary passages, Ilse of contrast agents may result in allergic-type reactions or, rarely, kidney damage. (Rodgers, 2006)

Magnetic Resonance Imaging (MRI) can provide three-dimensional images of the kidneys, blood vessels, and structures surrounding the kidneys. MRI helps distinguish tumors from cysts. When used with a paramagnetic contrast agent to enhance images, MRI can identify disorders of kidney blood vessels. People who require evaluation of the kidney blood vessels and who are at risk of reactions to radiopaque contrast agents can undergo MRI rather than CT. (Rodgers, 2006)

Computed Tomography since its introduction 30 years ago Computed Tomography (CT) has evolved from a prime imaging tool to one capable of volumetric scanning. The impact of this development has been felt in everything from clinical application to workflow, which has even affected the computer tomography vernacular. (Gaafer, 2004)

Today's multidetector scanners represent a huge technical leap since dedicated brain imager was unveiled in 1972. The clinical advances by these devices, which are capable of acquiring four CT slices rotation, have been impressive. Foremost among them is CT and new 16-slice units. (Gaafer, 2004)

Prior to Multidetector Computed Tomography (MDCT), the last major innovation in CT came with the introduction of spiral scanning in 1989. The developed CT from step-and-shot technology in which patients were moved incrementally between slices, to new acquisition in which patient slide through a rotation in spiraling pattern. (Gaafer, 2004)

The ability to acquire a constant flow of data was CT's first volumetric data collection and represented the first shill in thinking data t step - away from "slices" and toward the concept of volume. (Gruffer, 2004) .

Helical CT (sometimes called spiral CT), performed by continuously moving the person through the CT scanner, permits special images or certain structures and more rapid completion of the scanning process.

Helical CT without the use of a radiopaque contrast agent is useful for people who may have kidney stones or for people who have suffered trauma in whom bleeding into the kidney or surrounding tissues must be identified rapidly. A radiopaque contrast agent is often used in CT examinations. The intravenous contrast agent provides extra detail about the kidney arteries and veins, about certain kidney tumors (such as renal cell cancer), and about polycystic kidney disease. (Nagel, 2004)

1.2 Problem of the study:

There is direct impact of renal pathology in the diameter of kidneys pelvic. Measurement of pelvic diameter can be used as indicator of renal pathology.

1.3 Objective of the study:

- To measurement the kidneys pelvic diameter in Sudanese population.
- To assess the effect of pathology ,age and sex in diameter of the renal pelvic
- To assess the accuracy of CTU to determine renal pelvic diameter and diagnoses

1.4 The study area:

The study was done in police hospital and al nilin center.

1.5 Duration of the study:

The duration of the study six months.

1.6 Overview of the study:

Chapter one include introduction.

Chapter two shows theoretical background and previous study. Chapter three explains material and methods.

Chapter four shows the analysis and results.

Chapter five discussion , conclusion and recommendations.

CHAPTER TWO

Literature Review

CHAPTER TWO

Literature Review

2-1 Anatomy of the Kidneys:

The kidneys are the primary organs of the urinary system. The kidneys are the organs that filter the blood, remove the wastes, and excrete the wastes in the urine. They are the organs that perform the functions of the urinary system. The other components are accessory structures to eliminate the urine from the body.(Elaine,2003)

The paired kidneys are located between the twelfth thoracic and third lumbar vertebrae, one on each side of the vertebral column. The right kidney usually is slightly lower than the left because the liver displaces it downward. The kidneys protected by the lower ribs, lie in shallow depressions against the posterior abdominal wall and behind the parietal peritoneum. This means they are retroperitoneal. Each kidney is held in place by connective tissue, called renal fascia, and is surrounded by a thick layer of adipose tissue, called perirenal fat, which helps to protect it. A tough, fibrous, connective tissue renal capsule closely envelopes each kidney and provides support for the soft tissue that is inside. (Elaine ,2003)

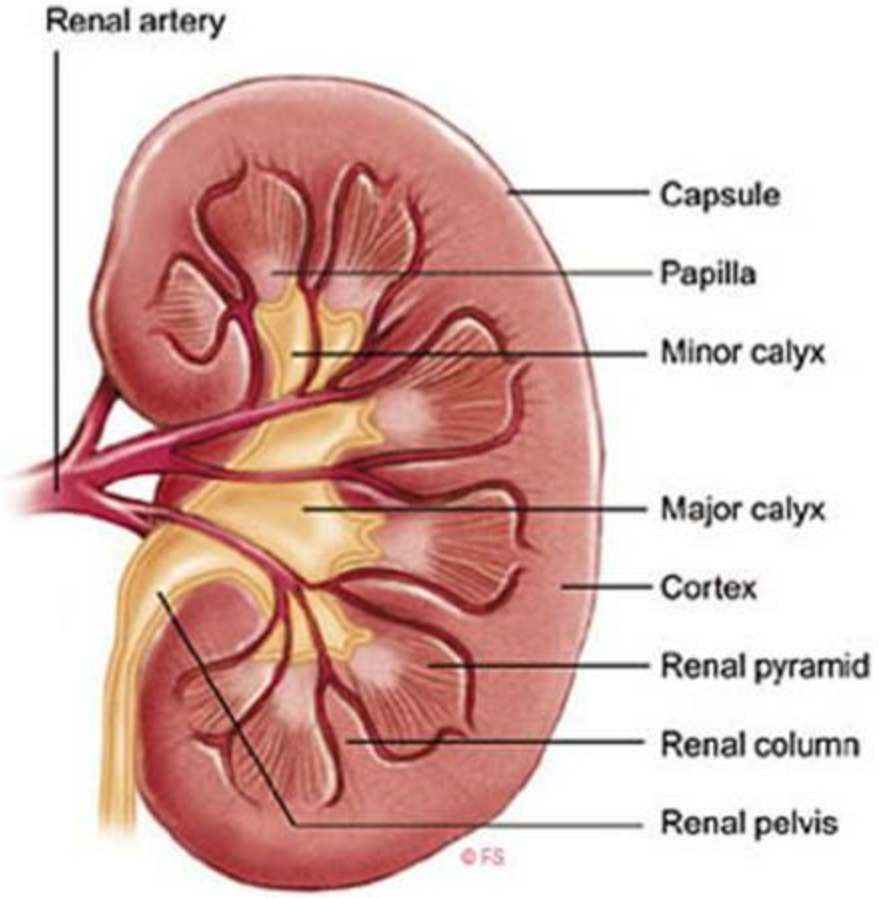

Figure 2.1anatomy of the renal pelvic (Elaine ,2003)

In the adult, each kidney is approximately 3 cm thick, 6 cm wide, and 12 cm long. It is roughly bean-shaped with an indentation, called the hilum on the medial side, the hilum leads to a large cavity, called the renal sinus, within the kidney. The ureter and renal vein leave the kidney, and the renal artery enters the kidney at the hilum. (Elaine .2003)

The outer, reddish region, next to the capsule, is the renal cortex This surrounds a darker reddish-brown region called the renal medulla. (Elaine .2003)

The renal medulla consists of a series of renal pyramids, which appear striated because they contain straight tubular structures and blood vessels. The wide bases of the pyramids arc adjacent to the cortex and the pointed ends, called renal papillae, are directed toward the center of the kidney. Portions of the renal cortex extend into the spaces between adjacent pyramids to form renal columns. The cortex and medulla make up the parenchyma, or functional Tissue, of the kidney. (Elaine ,2003)

The central region of the kidney contains the renal pelvis, which is located in the renal sinus and is continuous with the ureter. The renal pelvis is a large cavity that collects the urine as it is produced. The periphery of the renal pelvis is interrupted by cuplike projections called calyces. A minor calyx surrounds the renal papillae of each pyramid and collects urine from that pyramid. Several minor calyces converge to form a major calyx, from the major calyces the urine flows into the renal pelvis and bon then into the ureter. (Elaine .2003)

Each kidney contains over a million functional units, called nephrons, in the parenchyma (cortex and medulla) A nephron has two parts: a renal corpuscle and a renal tubule. The renal corpuscle consists of a cluster of capillaries, called the glomerulus. surrounded by a double-layered epithelial cup, called the glomerular capsule. An afferent arteriole leads into the renal corpuscle and an efferent arteriole leaves the renal corpuscle. Urine passes from the nephrons into collecting ducts then into the minor calyces. (Elaine ,2003)

The juxtaglomerular apparatus, which monitors blood pressure and secretes renin, is formed from modified cells in the afferent arteriole and the ascending limb of the nephron loop. (Elaine, 2003)

2.1.1 Blood supply:

The kidneys are full of blood vessels. Blood vessels are integral to efficient kidney function. Every function of the kidney involves blood therefore, it requires a lot of blood vessels to facilitate these functions. Together, the two kidneys contain about 160 km of blood vessels. The renal circulation receives around 20% of the cardiac output. It branches from the abdominal aorta and returns blood to the ascending vena cava. (Elaine ,2003)

2.1.2 Nerve supply:

Stimulation of the spinal parasympathetic fibres in the greater and lesser splanchnics causes vasodilatation of the renal blood-vessels, but the spinal parasympathetic fibres in the lumbar sympathetic trunk do not play a prominent part in such vasodilatation.(Kure, etal 1993)

The spinal parasympathetic fibres exert specific secretory effects upon the kidney. The greater splanchnics contain fibres which promote elimination of the total nitrogen; the lesser splanchnics excite the elimination of phosphate; while fibres in the lumbar sympathetic trunk play a less significant part in the elimination of both total nitrogen and phosphate. The greater and lesser splanchnics, as well as fibres from the

lumbar sympathetic have a markedly excitatory influence on the lamination of sodium chloride, although there are individual differences as to the extent of this influence. (Kure, etal, 1993)

2.2 Pathology:

2.2.1 Renal Stone:

A kidney stone, also known as a renal calculus, is a solid concretion or crystal aggregation formed in the kidneys from dietary minerals in the urine. Urinary stones are typically classified by their location in the kidney (nephrolithiasis) or by their chemical composition (calcium-containing, struvite, uric acid, or other compounds). Kidney stones are a significant source of morbidity. 80% of those with kidney stones are men. Men most commonly experience their first episode between ages 30- 40 years, while for women the age at first presentation is somewhat later. (Stoller , etal, 2008)

Kidney stones typically leave the body by passage in the urine stream, and many stones are formed and passed without causing symptoms. If stones grow to sufficient size (usually at least 3 millimeters (0.12 in)) they can cause obstruction of the ureter.

Ureteral obstruction causes postrenal azotemia and hydronephrosis (distension and dilation of the renal pelvis and calyces), as well as m of the ureter. This leads to pain, most commonly felt in the (the area between the ribs and hip), lower abdomen and condition called renal

colic). Renal colic can be associated with nausea, vomiting, fever, blood in the urine, pus in the urine, and painful urination. Renal colic typically comes in waves lasting 20 - 60 minutes, beginning in the flank or lower back and often radiating to the groin or genitals. The diagnosis of kidney stones is made on the basis of information obtained from the physical examination, urinelysis, and radiographic studies.

Ultrasound examination and blood tests may also aid in the diagnosis. (Alfred, 2009)

2.2.2 Renal mass:

Renal masses and cysts comprise a group of benign and cancerous tumors that arise in the kidneys. Most common among these are simple renal cysts (60-70% of all renal masses), which are benign, fluid-filled structures that generally produce no symptoms and are identified incidentally after radiology testing that is performed for other reasons (Alfred, 2009).

The most important distinction for patients with a renal mass or cyst is to determine whether or not the abnormality represents a cancer. Fortunately, a variety of radiological tests are available (including ultrasound, CT scan and MRI) that may permit distinction between benign and malignant kidney cysts and solid masses. In cases where a simple (benign) cyst is diagnosed, no additional treatment or follow-up is generally required. However, when a solid kidney mass or a cyst that

is suspicious for cancer is noted. follow-up imaging studies and/or surgical intervention is often recommended.. (Alfred• 2009)

2.2.3 Hydronephrosis:

Literally “water inside the kidney" - refers to distension and dilation of the renal pelvis and calyces, usually caused by obstruction of the free flow of urine from the kidney. Untreated, it leads to progressive atrophy of the kidney. In cases of hydroureteronephrosis, there is distention of both the ureter and the renal pelvis and calices. (Kumar, etal, 2005)

The signs and symptoms of hydronephrosis depend upon whether the obstruction is acute or chronic, partial or complete, unilateral or bilateral. Hydronephrosis that occurs acutely with sudden onset (as caused by a kidney stone) can cause intense pain in the flank area (between the hips and ribs), while a chronic occurrence that develops gradually will present with no pain or attacks of a dull discomfort. Nausea and vomiting may also occur. An obstruction that occurs at the urethra or bladder outlet can cause pain and pressure resulting from distension of the bladder. Blocking the flow of urine will commonly result in urinary tract infections which can lead to the development of additional stones, fever, and blood or pus in the urine. If complete obstruction occurs, kidney failure may follow.(Porter, 2009)

2.2.4 Compensatory renal hypertrophy:

Increased kidney size and function in circumstances where there is a reduction in nephron number. The causes include: congenital, as in the oligomeganefronia, unilateral renal agenesis, and unilateral nephrectomy due to illness or living kidney donation. A special case without nephron reduction occurs in the early stages of diabetes (hypertrophy, hyperfiltration and hyperperfusion). After unilateral renal clearance, the contralateral kidney undergoes a phenomenon of morphological and functional hypertrophy, reaching a glomerular filtration rate of 60-70% of prenefrectomia to seven days, which may progress over time to six or twelve months (Alfred, 2009)

2-2-5 Chronic Pyelonephritis:

Chronic pyelonephritis is characterized by scarring and shrunken volume (atrophy) of the kidneys.

Unlike acute pyelonephritis in which there is bacterial infection of the kidney, chronic pyelonephritis is a kidney condition that develops over time due to damage of kidney tissue. In adults, infection usually plays a role, but the underlying disorder usually involves an underlying structural or functional abnormality in the urinary tract that predisposes an individual to kidney infections. It results in decreased ability of the kidneys to function (renal failure). Abnormalities that increase the risk of chronic pyelonephritis with repeated urinary tract infections include

diabetes, kidney stones (calculi), use of certain analgesics, and urinary tract obstruction. Infection alone rarely leads to chronic pyelonephritis and loss of kidney function. . (Alfred, 2009) Chronic pyelonephritis can develop without infection. Individuals with an abnormality of the junction between the ureter and bladder (vesicoureteral junction) in childhood may develop chronic pyelonephritis.

Abnormality of the vesicoureteral junction, a congenital condition in which the juncture between the ureters and bladder is weak, allows urine to flow backward from the bladder to the ureter and up into the kidney. Severe reflux alone can lead to kidney scarring, even in the absence of other factors known to cause kidney scarring. The scarring of the kidneys associated with vesicoureteral reflux is similar to that seen with repeated infection combined with underlying structural abnormality. Some authorities theorize that kidney scarring due to reflux of urine (reflux nephropathy) may be an autoimmune process. Other noninfectious conditions that may scar the kidneys similarly to vesicoureteral reflux are long-standing high blood pressure (hypertension) and use of certain analgesics. Individuals with increased risk include those with congenital urinary tract abnormalities, and those with recurrent urinary tract infections.(Alfred, 2009)

2.3 physiology:

2.3.1 Maintenance of Homeostasis:

The kidneys maintain the homeostasis of several important internal conditions by controlling the excretion of substances out of the body. (Elaine, 2003)

The kidney can control the excretion of potassium, sodium, calcium, magnesium, phosphate, and chloride ions into urine. In cases where these ions reach a higher than normal concentration, the kidneys can increase their excretion out of the body to return them to a normal level. Conversely, the kidneys can conserve these ions when they are present in lower than normal levels by allowing the ions to be reabsorbed into the blood during filtration (Elaine .2003).

The kidneys monitor and regulate the levels of hydrogen ions (H+) and bicarbonate ions in the blood to control blood pH. H+ ions are produced as a natural byproduct of the metabolism of dietary proteins and accumulate in the blood over time. The kidneys excrete excess II+ ions into urine for elimination from the body.

The kidneys also conserve bicarbonate ions, which act as important p1-1 buffers in the blood. (Elaine ,2003)

The cells of the body need to grow in an isotonic environment in order to maintain their fluid and electrolyte balance. The kidneys maintain the body's osmotic balance by controlling the amount of water that is

filtered out of the blood and excreted into urine. When a person consumes a large amount of water, the kidneys reduce their reabsorption of water to allow the excess water to be excreted in urine. This results in the production of dilute, watery urine. In the case of the body being dehydrated, the kidneys reabsorb as much water as possible back into the blood to produce highly concentrated urine full of excreted ions and wastes. The changes in excretion of water are controlled by antidiuretic hormone (ADH). ADH is produced in the hypothalamus and released by the posterior pituitary gland to help the body retain water. (Elaine ,2003).

The kidneys monitor the body's blood pressure to help maintain homeostasis. When blood pressure is elevated, the kidneys can help to reduce blood pressure by reducing the volume of blood in the body. The kidneys are able to reduce blood volume by reducing the reabsorption of water into the blood and producing watery, dilute urine. When blood pressure becomes too low, the kidneys can produce the enzyme renin to constrict blood vessels and produce concentrated urine, which allows more water to remain in the blood (Elaine ,2003).

2.3.2 Filtration:

Inside each kidney are around a million tiny structures called nephrons, the nephron is the functional unit of the kidney that filters blood to produce urine. Arterioles in the kidneys deliver blood to a bundle of

capillaries surrounded by a capsule called a glomerulus. As blood flows through the glomerulus, much of the blood's plasma is pushed out of the capillaries and into the capsule, leaving the blood cells and a small amount of plasma to continue flowing through the capillaries. The liquid filtrate in the capsule flows through a series of tubules lined with filtering cells and surrounded by capillaries. The cells surrounding the tubules selectively absorb water and substances from the filtrate in the tubule and return it to the blood in the capillaries. At the same time, waste products present in the blood are secreted into the filtrate. By the end of this process, the filtrate in the tubule has become urine containing only water, waste products, and excess ions. The blood exiting the capillaries has reabsorbed all of the nutrients along with most of the water and ions that the body needs to function. (Elaine , 2003)

2.3.2 Storage and Excretion of Wasters:

After urine has been produced by the kidneys, it is transported through the ureters to the urinary bladder. The urinary bladder tills with urine and stores it until the body is ready for its excretion.

When the volume of the urinary bladder reaches anywhere from 150 to 400 milliliters, its walls begin to stretch and stretch receptors in its walls send signals to the brain and spinal cord.

These signals result in the relaxation of the involuntary internal urethral sphincter and the sensation of needing to urinate.

Urination may be delayed as long as the bladder does not exceed its maximum volume, but increasing nerve signals lead to greater discomfort and desire to urinate (Elaine , 2003).

Urination is the process of releasing urine from the urinary bladder through the urethra and out of the body. The process of urination begins when the muscles of the urethral sphincters relax, allowing urine to pass through the urethra. At the same time that the sphincters relax, the smooth muscle in the walls of the urinary bladder contract to expel urine from the bladder (Elaine , 2003).

2.3.3 Production of Hormones:

The kidneys produce and interact with several hormones that are involved in the control of systems outside of the urinary system.

Calcitriol is the active form of vitamin D in the human body. It is produced by the kidneys from precursor molecules produced by UV radiation striking the skin. Calcitriol works together with parathyroid hormone (PTH) to raise the level of calcium ions in the blood stream. When the level of calcium ions in the blood drops below a threshold level, the parathyroid glands release PTH, which in turn stimulates the kidneys to release calcitriol. Calcitriol promotes the small intestine to absorb calcium from food and deposit it into the blood stream. It also stimulates the osteoclasts of the skeletal system to break down bone matrix to release calcium ions into the blood. (Elaine,2003)

Erythropoietin. Erythropoietin, also known as EPO, is a hormone that is produced by the kidneys to stimulate the production of red blood cells. The kidneys monitor the condition of the blood that passes through their capillaries, including the oxygen-carrying capacity of the blood. When the blood becomes hypoxic, meaning that it is carrying deficient levels of oxygen, cells lining the capillaries begin producing EPO and release it into the blood stream. EPO travels through the blood to the red bone marrow, where it stimulates hematopoietic cells to increase their rate of red blood cell production. Red blood cells contain hemoglobin, which greatly increases the blood's oxygen-carrying capacity and effectively ends the hypoxic conditions (Elaine,2003).

Renin. Renin is not a hormone itself, but an enzyme that the kidneys produce to start the renin-angiotensin system (RAS). The RAS increases blood volume and blood pressure in response to low blood pressure, blood loss, or dehydration. Renin is released into the blood where it catalyzes angiotensinogen from the liver into angiotensin I. Angiotensin I is further catalyzed by another enzyme into Angiotensin II.(Elaine , 2003).

Angiotensin II stimulates several processes, including stimulating adrenal cortex to produce the hormone aldosterone.

Aldosterone then changes the function of the kidneys to increase reabsorption of water and sodium ions into the blood, increasing blood

volume and raising blood pressure. Negative feedback from increased blood pressure finally turns off the RAS to maintain healthy blood pressure levels. (Elaine , 2003)

2.4 Multidetector computed tomography:

`Multidetector CT' (MDCT) denotes the ability of CT scanner to acquire more than one slice simultaneously, to be capable of doing so the detector system most necessarily be composed of more than a single row of detector elements. Other terms often used, such as `Multidetector CT', are somewhat misleading, as the number of detector rows generally larger than the number of slices. The latter, however, is the decisive feature of such a scanner. (Kalender, 2000)

The Multidetector CT is started in 1992 with the introduction of the Elscint CT Twin, a dual slice scanner. The advantages of a MDCT scanner can shortly be characterized by acronyms R, S, V, and P which stand for:

Resolution: improve spatial resolution along the z-axis.

Speed: reduce time for warming.

Volume; increase length than can be Scared for a given set of scan parameters.

Power: increasing usage of x-ray tube power.

In 19%, the first four-slice scanners were presented, followed by the introduction of 16-slice scanner in 2001. The rapid development in this field is expressed by the presentation of 32- and 40-slice scanners and the announcement of 64-slice scanner at 2003 RSNA meeting. Not only the number of slice has increased, but also the rotational speed, from formerly is to presently 0.375 s per rotation. (Kalender, 2000)

Whereas dual-slice scanners allowed improving one specific aspect only (R or S or V or P), scanners with 16 and more slice are virtually unlimited (R and S and V and P).This has opened the filed for new or improved applications, such as cardiac c-r, CT angiography, CT perfusion, polytaruma CT, and orthopedic, to only name the most important. (Kalender, 2000)

2.5 Detector layout and slice definition:

The essential precondition for multidetector CT is a multirow detector array. Both gas detector and 4th generation scanners with 360° detector rings are no longer compatible with MDCI requirement. Consequently, all MDCT scanners are of the 3s generation rotate-rotate type and employ solid-state detectors. (Nagel, 2004)

With four slice scanners, various designs were used which differed in the number of detector rows, the dimension of the detector elements and the total width of the array. The universal matrix design used by GE (General Electric company) allowed using the same detector for an

eight-slice scanner also, which was introduce in 2001, at the expense of a large number septa which are not contributing to detection. The progressive design commonly employed by Philips and Siemens aimed to reduce the number of septa between the rows, thereby improving the geometric efficiency of the array. The hybrid design introduce by Toshiba was the only one that offered four slice in sub-millimeter acquisition mode, however at the expense of an even greater number of septa. In addition, the Toshiba layout provided a total width of 32 mm for scanning four slices each 8 mm thick simultaneously. (Nagel, 2004)

With 16-slice, all manufacturers employed a hybrid layout, allowing for sub-millimeter acquisition in 16-slice mode. Only the size of the smallest detector elements and the total width of the array differ, with each manufacturer claiming to offer the most optimal design. However, the question what is optimal depends on all aspects involved (z-resolution, volume coverage, dose), not only one (e.g z-resolution). As is daily life, the optimum is the result of the best compromise. This becomes evident in cardiac CT, which is the most demanding new MDCT application. (Nagel, 2004)

Slice definition is a achieved by combining adjacent detector rows and employing appropriate pre- and post- patient — collimation. Thus variety of slice collimations can be offered, such as (4.5) mm, (4.25) mm, (4.1) mm and (2.5) mm for the progressive design shown here. Similar considerations apply to the others designs. It important to note

that the slice thickness used for image presentation can differ from that during data acquisition (slice collimation). Thicker slices can be generated from thin slice data, either during reconstruction or by post-processing. However, once a certain slice collimation has been selected, it is not possible to reconstruct thinner slice later. (Kalender, 2000)

Hybrid designs arc also used for the most recently presented scanners with 32 and more slices. However, when going to detector array with more than approximately 45 rows, a technological barrier appears. This is caused by the minimal spacing of the wirebods linked to the data readout lines, which cannot he made smaller than 60 mm. in traditional, front-illuminated photodiodc design, these lines must be arranged in a horizontal fashion, thus limiting the number of detector rows which can electrically be connected to the ASIC of the data acquisition system. This bottle neck has recently been overcome with the advent of back-illuminated photodiodes. As these can vertically be guided to the ASIC via a conductive epoxy, the number of the detector rows is no longer limited by spatial restrictions. (Kalender, 2000)

2. 6 Z-Interpolation, pitch and mAs per slice conception:

Multidetector Computed Tomography can be used both in sequential and spiral scanning modes. As with single slice CT (SSCT), data acquired in single mode have to be interpolated in order to achieve axial slice. However, a different interpolation scheme is used in most MDCT

implementation. While a two-point interpolation between a pair of data point closest to the reconstruct slice position in employed in SSCT, MDCT scanners from Philips, Siemens and Toshiba make use of a multi-point interpolation (z-filterinal. All data points falling inside a pre-selected filter width FW (which defines the reconstructed slice thickness) are taken in account. either equally or in a weighted fashion. (Kalender, 2000)

The new interpolation scheme offers significant advantages; other than for single slice scanners, slice profile width (effective slice thickness) can be kept constant independent of the pitch factor selected. However, also different from SSCT, image noise now changes with pitch, as the number of data points available for interpolation also changes. To avoid this, the electric tube current is automatically adapted proportional to the increase (or decrease) in pitch factor settings (`effective mAs' or `mAs per slice' conception). (Kalender, 2000)

As a consequence, slice thickness, image noise and average patient dose are independent of the pitch factor setting for a pre-selected, constant value of mAs per slice i.e. electric mAs divided by pitch. So pitch merely serves to control the scan speed. This holds for MSCT scanners of Philips, Siemens, whereas Toshiba users need to adapt the mAs setting manually if felt necessary. By using pitch factors<, greater data density is achieved which can be used to virtually increase the available mAs per slice value despite the limited load ability of the x-ray tube. In

addition spiral artifacts are reduce to pitch factor settings<1, both at the expense of reduce volume coverage per unit time, however. Some manufacturer like GE and Toshiba also offer (or recommended) dedicated pitch factor settings only (`preferred pitch') in order to optimize data sampling and to minimize artifacts , while Philips and Siemens users are not restricted in this context. (Kalender, 2000)

The pitch factor used here follows the universal pitch definition given in IBC standards as the ratio of the table feed per rotation and the total collimation Nth, where pitch 1 denotes a 'slice-by¬slice acquisition'. Most manufacturers now comply with this definition instead of another one formerly (`volume pitch' p* = table feed divided by slice collimation h only), resulting in large values (1 to 8 for four-slice, 2 to 30 for 16-slice scanner). This was highly misleading, as a scanner can be used in different 'number of slice' configuration (e.g. 16-, 6-, 4-, and 2-slice modes with some 16-slice scanners). (Kalender, 2000)

2-7 Multhietettor CT of the kidney:

Multidetector Cl' (MIX' scanners allow for fast investigation with high spatial resolution. (Foley WO, 2003) Narrow collimation results in isotropic voxels in 64-channel MDCT scanners of recent release. Images in arbitrarily reconstructed planes come close to the image quality in the original scan plane. Small slice thickness impnwes the detection of small structures and allows better discrimination of solid and cystic structures

as partial-volume effects diminish. Slice fusion options improve contrast and contrast-to-noise ratio. Due to short scan times, the kidneys can be depicted in well-defined (dynamic) phases of contrast enhancement, so that lesions can be characterized more precisely. In practice, it is advisable to choose a reconstruction thickness of 3-5 mm as a compromise between spatial resolution and contrast-to-noise ratio. Depending on radiological findings, reconstructions in other planes and slice thickness down to the sub millimeter range can be added (depending on scanner type and number of detector rows available).

Multidetector CT increases dose as a result of thinner collimation, Over beaming, and over ranging effects. For example, in four-row scanners, effective dose is about 30% higher with a collimation of 1 mm than with a collimation of 2.5 mm. For that reason, and because the interval or breath-holding decreases, a collimation of 2.5 mm is recommended in these scanners. In current Multidetector scanners with more than lour rows that allow for two different collimations (millimeter and sub millimeter), radiation dose increases only by about 10% when the smaller collimation is chosen. In spiral technique, additional tube rotations have to be performed at the beginning and at the end of the scan range because adjacent data from both sides are necessary for image reconstruction (interpolation). Therefore, the scanned volume exceeds the reconstructed volume. The number of additional rotations depends on pitch, cone beam correction, and scanner type. The over

ranging effect may cause considerable increase of dose. (Tzedakis, 2005)

Dose limitation is possible with the application of dose modulation software. Dose modulation is based on the principle that decrease in body diameter (i.e., the anteroposterior diameter when compared to the lateral diameter) translates into decrease in radiation necessary to obtain a certain contrast-to-noise ratio in the resulting CT image data. (Tzedakis, 2005).

Images are usually reconstructed in the transversal plane. The corona) plane is suitable for reconstruction of an "insitu" perspective that resembles the view of the abdominal or urologic surgeon. The multiplanar reformation (MPR) describes the option plane reconstruction from voxel data sets. These planes of arbitrary can be chosen in an orthogonal plane (sagittal, coronal), oblique for example, for plane or even in a curved planar reconstruction (course of vessels). Best reconstruction results are obtained in a pseudo-two dimensional display with isotropic voxels. Maximum intensity projection (MIP) depicts the structures of highest CT density within a volume of interest. Volume rendering technique (VRT) is an image-processing option that emphasizes regions of selected CT density range, thereby accentuating specific tissues or organs. (Prokop, 2003),

2.8 Technique and Scanning Protocol

For confident diagnosis and management of renal dimensions, a dedicated, multiphase CT evaluation of the kidney is mandatory .Non-contrast scans and non-helically prior to helical scans may be performed. Use comparable collimation and delayed non-helical sections should be done approximately 2 min after helix. Minimum suggested mA on general electric Hi-Speed adjust appropriately for other scanners and Lower mA may be used in thin patients. Increased pitch will cause undesirable partial volume averaging when used in conjunction with collimation beyond 5 mm. If cannot achieve adequate z-axis coverage, use 7 or 8 mm collimation may need to do additional thinner sections for CT numbers. Use non-contrast scans to localize starting location and this would be cephalic to caudal or vice versa. 1f combined In exam to include thorax, start at bottom of kidney and scan cephalic. need in reducing mA or completing thorax non-helically, if scanner permits include liver. If patient cannot hold breath, split helix with 7 sec pause after 15-20 sec.

Optimal for 3 mL/sec injection and delayed scans at 1 min. Finally, film images reconstructed with 5mm spacing, or read from workstation. (Federle, 1997)

2.8.1 protocol:

Scan mode: Helical, Scan parameters: 120 kVp, 280 mA, Length of helical exposure: 30-40 sec (approximate), Field of view: 30 to 40 cm, Pitch: 1:1, Collimation: 4-8 mm, Number of sections: 30-40 (approximate), Area of interest: From upper to lower pole of kidneys, Patient Instructions: Breath hold in mid-inspiration, Contrast Prefer: non-ionic 300 mgl/mL, Volume :120 mL (ionic or non-ionic), Rate: 3 mL/ sec, Scan delay: 60 sec; then repeat at 100 sec delay, Reconstruction algorithm: Standard, Reconstruction spacing: 2 mm and equal to collimation intervals. (Federle, 1997)

2.9 previous studies:

In study of (glodny,eta1,2011) showed that: The width of the renal pelvis on the contralateral side is the strongest independent predictor for hydronephrosis and the width of the renal pelvis. There is no link between croccing vessels and the width of the renal pelvis.

Another study of (Van Beer Be,1997) showed that: The three dimension CTU is not easily interpreted by clinical but is also improves the accuracy in diagnosing urinary tract abnormalities.

(Monshed,2011) showed that: The measurements of renal pelvis reported slightly difference regarding to gender (Male, Female) and side (RT, Lt). The right renal pelvis in male (4.6 ± 2.6cm2) larger in size than in female (3.8 = 2.3cm2) and left renal pelvis in male also had greater size (4.1 ± 1.5cm2) than in female (3.9 ± 1.2cm2).

(Awad 2013) showed that :the measurements of the right renal pelvic was greater than the left renal pelvic diameter.

CHAPTER THREE

MATERIAL AND METHODS

CHAPTER THREE

Materials and Methods

3.1 Materials:

3.1.1 Patients:

Analytical descriptive study was carried out for (50) patients whose undergone CTU, 25 adult male and 25 adult female in different age. Following information about patients was reported; age, sex and clinical finding. And that was from April until October 2018 in Nileain and Alribat hospital.

3.1.2 Machine:

3rd generation Siemens Somatom emotion duo. The emotion due multislice helical CT scanners, featuring (380-415) out voltage, (365-435) input range. Scanner gantry 70(cm) aperture, maximum scan filed view 50 (cm) ,70(cm) option. Nominal slice width for axial scans 0.6, 0.75, 1.0, 1.5, 3, 4.5, 5, 6, 9, 10.

3.2 Methods

3.2.1 CTU protocol:

The protocol used in siemnse 16 called abdomen routine.

3.2.2 Abdomen Routine:

KV120,Effective mAs140,Sli cecollimati on 1.5mm, Slice width 5.0mm, Feed/Rotation 24.0mm,Rotation time 0.5sec,Kemel B31F,Increment 5.0mm,P itch 1.

3.2.3 Contrast medium IV injection:

Start delay 50-60sec.

Flow rate 4.0m1/sec.

Total amount 100m1.

3.2.4 Technique:

Patient should be well hydrated.

Patient lies supine with arms over head on Citable.

Start with scout from diaphragmatic dome to symphsis pubis.

Field of view start from cost phrenic angles to symphsis pubis.

Slice thickness should not exceed 5mm itch of .05-1.

Scan should be done with single breath hold (helical scan).

Reconstruction in 2mm (better MPR).

Thin slab coronal (MIP MPR) images at the area of abnormal.

Scan delay 1-2 min (homogenous nephrographic phase) if renal parenchyma need to be evaluated (hypo vascular).

Scan delay 15-25 min excretory phase.

3.2.5 Image interpretation:

All images of the study are analyzed and coronal reformat image are obtain to assess the dimension of renal pelvic where the length and the width measure in three levels (upper, middle and lower) .

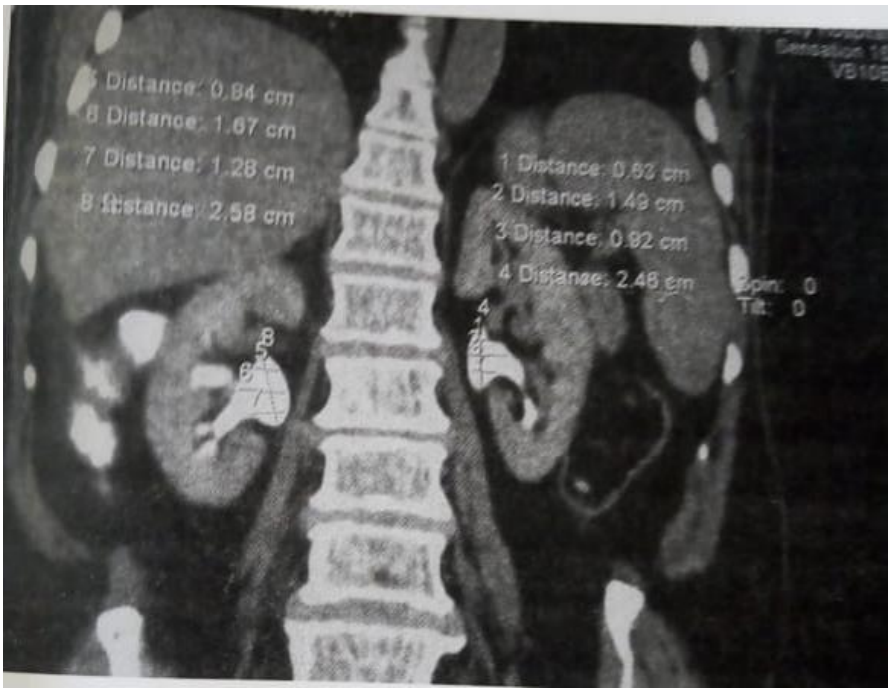

Figure 3.1 coronal show measurement of renal pelvic

Chapter Four
Results

Chapter Four

Results

The following tables and figures presented the data obtained from 50 patients who were examined for kidneys CTU, the length and width were measured for right and left kidneys, the final diagnosis was done and were stored as hydronephrosis, stones and normal results. The measurements were done to correlate the measurements with the final diagnosis and correlate the normal measurement with the age and gender.

Table 4.1 the gender, frequency and percentage:

Gender	Frequency	Percent
Male	25	50.0
Female	25	50.0
Total	50	100.0

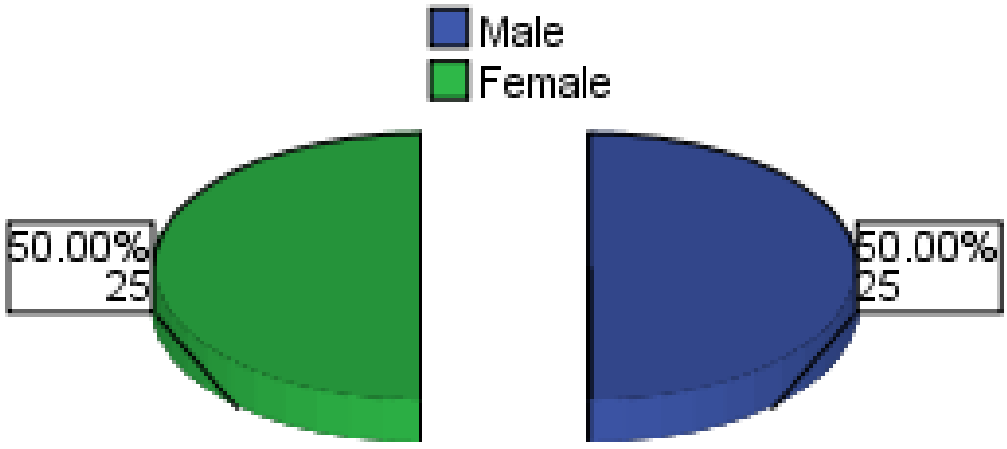

Figure 4.1 the gender frequency

Table 4.2 the classes and frequency.

Age	Frequency	Percent
3-14 Years	3	6.0
15-26 Years	6	12.0
27-38 Years	13	26.0
39-50 Years	11	22.0
51-62 Years	10	20.0
63-74 Years	5	10.0
More than 74 years	2	4.0
Total	**50**	**100.0**

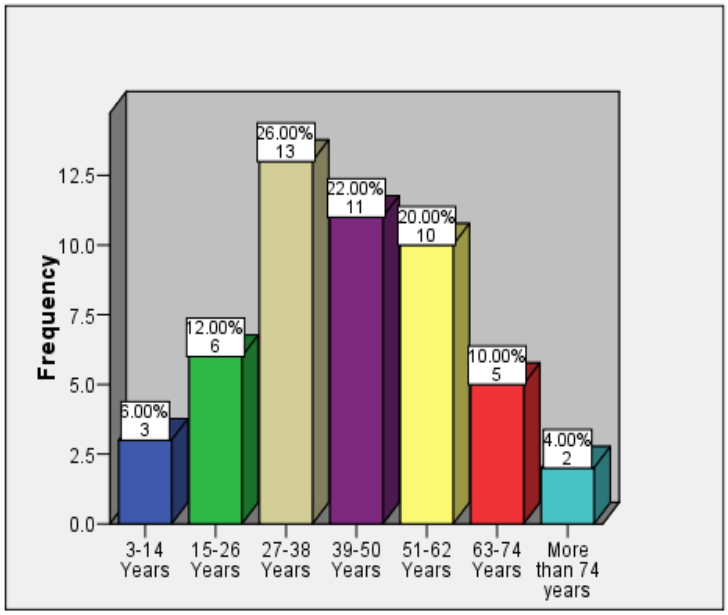

Figure 4.2 the classes and frequency.

Table 4.3 the mean and standard deviation (STDV) of the kidney measurement for the total sample

Item	Rt. Kidney length	Rt. Kidney width upper	Rt. Kidney width middle	Rt. Kidney width lower
Mean	2.01	1.1	1.45	1.23
STDV	±0.64	±0.42	±0.42	±42

Table 4.4 the mean and standard deviation (STDV) of the kidney measurement for the total sample

Item	LT Kidney length	LT Kidney width U	LT Kidney width M	LT Kidney width L
Mean	2.05	1.03	1.39	1.21
STDV	±0.89	±0.43	±0.59	±0.48

Table 4.5 the mean and standard deviation (STDV) of the RT kidney measurements for the normal and sample with hydronephrosis at *P-Value*= 0.05

Diagnosis	item	RT Kidney length	RT Kidney width U	RT Kidney width M	RT Kidney width L
Normal	Mean	1.90	0.98	1.38	1.11
	STDV	±0.52	±0.23	±0.39	±0.24
Hydronephrosis	Mean	2.22	1.30	1.61	1.47
	STDV	±0.77	±0.57	±0.51	±0.56
P- Value		0.51	0.050	0.043	0.052

Table 4.6 the mean and standard deviation (STDV) of the LT kidney measurement for the normal sample and sample with hydronephrosis at p-value = 0.05

Diagnosis	item	LT Kidney length	LT Kidney width U	LT Kidney width M	LT Kidney width L
Normal	Mean	1.86	0.91	1.23	1.08
	STDV	±0.44	±0.35	±0.52	±0.53
Hydronephrosis	Mean	2.46	1.28	1.74	1.49
	STDV	±1.36	±0.53	±0.76	±0.53
P- Value		0.04	0.057	0.054	0.052

Table 4.7 cross tabulation between RT kidney measurement and diagnosis as RT, LT bilateral hydronephrosis and other causes as stone

cross tabulation

		Diagnosis					Total	Chi – test linear by linear association
Site	Values	Normal	RT	LT	Bi	Other		
RT Kidney width U	0.5-2.7	34	3	3	6	4	50	0.53
RT Kidney width M	0.7-2.8	34	3	3	6	6	5	0.46
RT Kidney width L	0.3-2.7	34	3	3	6	4	50	0.72
RT Kidney length	0.9-3.8	34	3	3	6	4	50	0.76

Table 4.8 cross tabulation between LT kidney measurement and diagnosis as RT, LT bilateral hydronephrosis and other ca0uses as stone.

cross tabulation

		Diagnosis					Total	Chi – test linear by linear association
Site	Values	Normal	RT	LT	Bi	Other		
LT Kidney width U	0.3-2.6	34	3	3	6	4	50	0.58
LT Kidney width M	0.2-3.2	34	3	3	6	6	5	0.76
LT Kidney width L	0.5-2.8	34	3	3	6	4	50	0.58
LT Kidney length	0.7-5.8	34	3	3	6	4	50	0.112

Table 4.9 shows the correlation between the RT kidney and LT kidney measurement with the diagnosis as hydronephrosis for the total sample

	Diagnosis	LT Kidney length	LT Kidney width U	LT Kidney width M	LT Kidney width L	RT Kidney length	RT Kidney width U	RT Kidney width M	RT Kidney width L
Diagnosis		.113	.057	.076	.057	.076	.052	.044	.072
LT Kidney length	.113	.000	.000	.000	.000	.000	.000	.000	.000
LT Kidney width U	.057	.000	.000	.000	.000	.000	.000	.000	.000
LT Kidney width M	.076	.000	.000	.000	.000	.000	.000	.000	.000
LT Kidney width L	.057	.000	.000	.000	.000	.000	.000	.000	.000
RT Kidney length	.076	.000	.000	.000	.000	.000	.000	.000	.000
RT Kidney width U	.052	.000	.000	.000	.000	.000	.000	.000	.000
RT Kidney width M	.044	.000	.000	.000	.000	.000	.000	.000	.000
RT Kidney width L	.072	.000	.000	.000	.000	.000	.000	.000	.000
Correlation is significant at the 0.05 level (2-tailed)									

CHAPTER FIVE

CHAPTER FIVE

5.1 DISCUSSION:

In all samples the RT. renal pelvic is slightly bigger than the LT. renal pelvic. The length of RT. renal pelvic (2.02±0.65) and the width for upper (1.3±0.43) for the mid (1.47±0.44) and for lower (1.23±0.43).

The length of LT. pelvic (2.06±0.89) and the width for upper (1.04±0.45) for the mid (1.39±0.057) and for lower (1.21±0.49).

The normal measure of RT. renal pelvic length (1.91±0.53) and the upper width (0.99±0.24) ,for the mid (1.39±0.38) and the lower (1.11±0.25) .The measure agree with (Awad 2013) and differ from (monshed,2011) because he measure the renal pelvic from equation (length*width).

When the measure of the RT pelvic is more than: for length (2.23±0.76) the upper width (1.31±0.55) , mid (1.48±0.57) and for lower (1.87±0.45) the diagnosis was hydronephrosis.

The normal measure of LT. renal pelvic was: the length (1.85±0.45) and for upper width (0.92±0.34) ,mid (1.22±0.53) and for lower (1.09±0.53).

When the measure of LT. renal pelvic is more than: the length (2.45±0.05) for the upper width (1.29±.0.54) ,for mid (1.46±0.77) and for lower (1.48±0.54) the diagnosis was hydronephrosis.

There was direct impact between diagnosis of hydronephrosis and width agree with (glodny. Rapl Unterholiner. Rehder. Strsak. Herwing and Pertersen.Austria.2011).

5.2 Conclusion:

Multidetector computed tomography is considered now as the modality of choice for the renal organs especially kidney imaging because it provides the precise view of anatomical structures.

The RT renal pelvic is slightly bigger than the LT. renal pelvic.

Determine the range of normal diameter of renal pelvic and hydronephrosis help in diagnoses of renal pathology.

Computed Tomography Urology (CTU) is high accuracy in evaluated of renal abnormalities.

5.3 Recommendations:

The study end within the following recommendations:

- Further studies in evaluation renal dimensions with larger sample of population for more accurate results.
- Further studies must achieve bearing in mind the body weight and height.
- .Furth, studies must achieve with the effect the age and gender.
- . Ultrasound, CT and MRI remain the methods of choice in current clinical practice. Me advantages of each method should be weighed against the cost, availability of equipment, personal expertise, patient demographics and the experience of the clinician who analysis the information.

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Appendix

Appendix

Data collecting sheet

No	Age	Gender	Pelvic diameter								Diagnosis
			RT kidney				LT kidney				
			Length	width			Length	width			
				U	M	L		U	M	L	